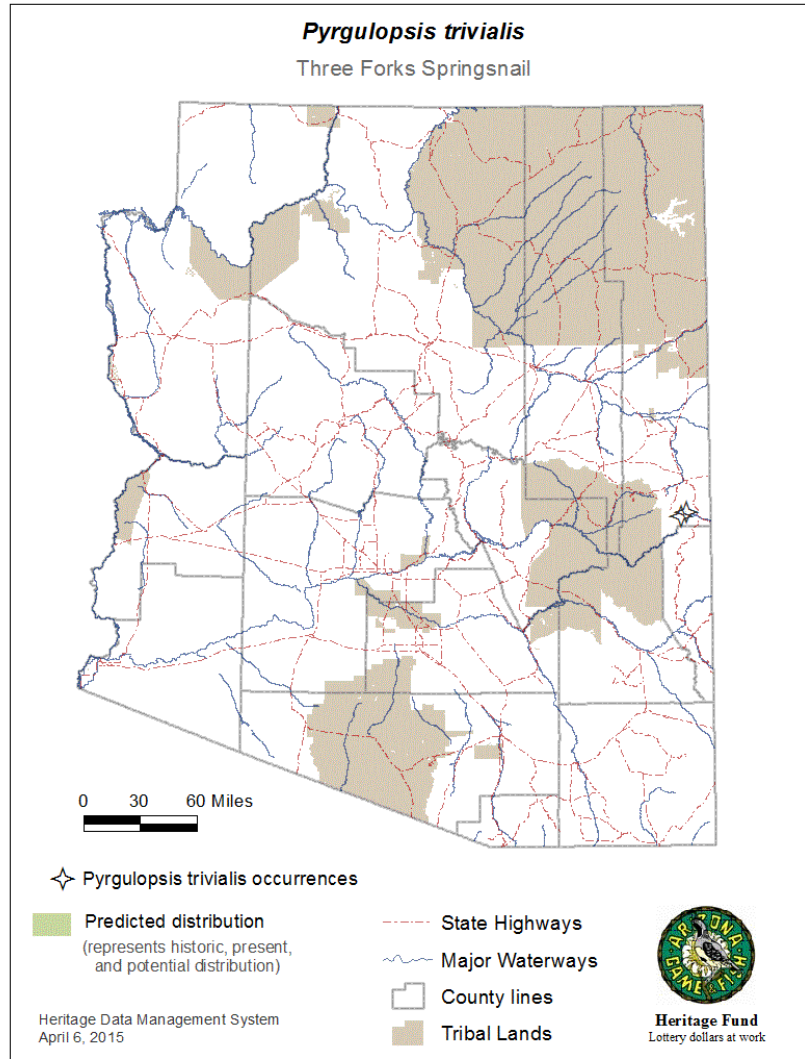


THREE FORKS SPRINGSNAIL CONSERVATION GUIDELINES

INTRODUCTION

The Three Forks springsnail (*Pyrgulopsis trivialis*) is an endemic species which occurs in very limited distribution in Apache County, east-central Arizona (Fig 1). Historically, the springsnail occurred in numerous springs and seeps along Boneyard Creek and the North and East Forks of the Black River. However, its range has been reduced and is now only found at two spring complexes (Boneyard Bog and Boneyard Creek Springs) on the southern slopes of the White Mountains. Associated aquatic vegetation includes watercress (*Nasturtium* sp.), crowfoot (*Ranunculus*), and algae. The Apache-Sitgreaves National Forest (U.S. Forest Service (USFS)) is responsible for the management of the suitable Three Forks springsnail habitat (USFWS 2012).

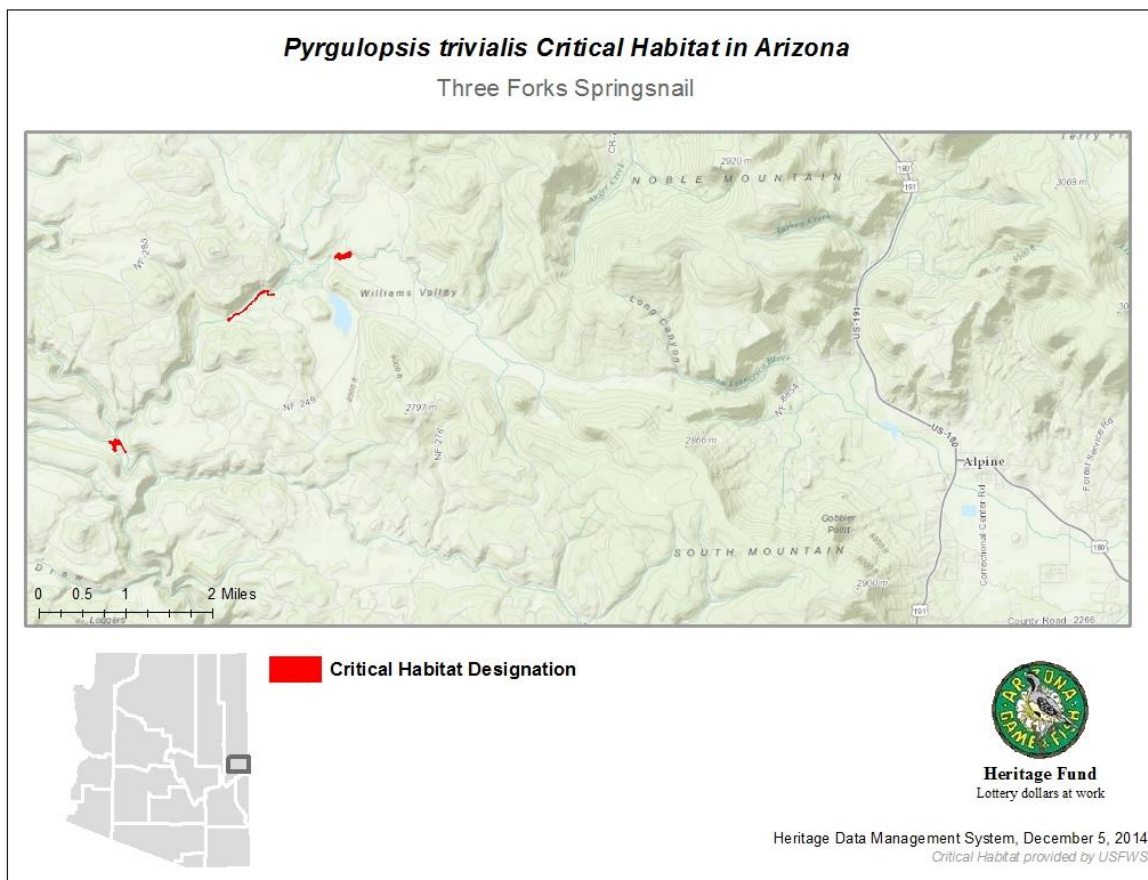
Figure 1. Distribution of Three Forks springsnail in Arizona.



The springsnails' limited range, poor dispersal ability, and sensitivity to environmental change make them vulnerable to habitat destruction and perturbation. Primary threats include soil erosion during storm events following high-intensity wildfire, application of aerial chemical fire retardant, predation by nonnative crayfish, and habitat destruction from excessive elk wallowing. High risk threats that could affect the species in the foreseeable future include the use of fire retardant chemicals during future wildfires, potential spread and competition with New Zealand mudsnails, and the potential for climate change and drought to dry its springhead habitat (USFWS 2012).

In 2012, the U.S. Fish and Wildlife Service (USFWS) listed the Three Forks springsnail as endangered and designated approximately 17.2 acres of critical habitat in Apache County, Arizona (Fig 2). Current conservation measures include the USFS established enclosures which exclude livestock and prevent unauthorized access at Boneyard Bog, the crayfish trapping and springsnail monitoring programs implemented by the Arizona Game and Fish Department (AGFD), and a captive refugium for the Three Forks Springsnail established at the Phoenix Zoo, in coordination with USFS and AGFD (USFWS 2012). Additional recovery efforts were initiated in 2014 with the modification of habitat in two springboxes at Three Forks and the installation of protective habitat enclosures around springsnail-occupied springs along Boneyard Creek (Sorensen and Lerich 2015). The Department's Pinetop Office has recently completed construction of secured wetland habitat at the regional office location that is anticipated to provide suitable habitat for a refuge population of the springsnail in 2016 (pers. comm. D. Groebner 2015).

Figure 2. Critical habitat for Three Forks springsnail in Arizona.



GENERAL BIOLOGY

The Three Forks Springsnail is a member of the genus *Pyrgulopsis* in the family Hydrobiidae. It is strictly aquatic and respiration occurs through an internal gill known as a ctenidium. The shell is narrowly elongate with a relatively long spire, variably sized with a height ranging from 0.06 to 0.19 in (1.5 to 4.8 mm), and tan in color. The snail has dark pigments on the snout and tentacles, lighter pigment on the sides of the head/foot, and an amber colored operculum (flap) (Taylor 1987; Hershler and Landye 1988; Hershler and Ponder 1998). Lifespan may range from 9 to 15 months (Pennak 1989).

Reproduction

The Three Forks springsnail reproduces via copulation and is oviparous, with females depositing a single small egg capsule on the hard substrate surface. The larval stage is completed inside the hemispherical to spherical shaped egg capsule, and upon hatching, tiny snails emerge. Sexual dimorphism is significant with females being noticeably larger than males (Hershler 1998; Hershler and Ponder 1998).

Movement

Mobility is limited for this endemic species and significant migration likely does not occur, however some snails may passively disperse by floodwaters or as a result of becoming attached to bird feathers.

HABITAT REQUIREMENTS

Springsnails are found within relatively narrow habitat parameters with distribution and abundance being influenced by water depth, distance from springhead, pH, substrate, temperature, dissolved carbon dioxide, dissolved oxygen, and conductivity (Hershler 1998; Mladenka and Minshall 2001; Martinez and Myers 2008; Martinez and Rogowski 2011). Dissolved salts may also be important as they are essential for shell formation (Pennak 1989). Physical and biological features such as cobble, gravel, woody debris, leaf matter, and aquatic vegetation are essential for cover, shelter, egg laying, and grazing (Taylor 1987; Hershler 1998; Hershler and Ponder 1998). Three Forks springsnails will inhabit a variety of permanent waters including free-flowing springheads, spring runs, spring seeps, concrete boxed springheads, and shallow spring-fed ponds. The two spring complexes where they are extant are spread across 3.7 miles (6 km) of perennial flowing stream and consist of several spring sources found in shallow canyon drainage and open mountain meadows within ponderosa pine (*Pinus ponderosa*) at an elevation of 8,200 feet (2,500 m) (Martinez and Myers 2008; Martinez and Rogowski 2011; USFWS 2012).

Population expansion and viability of the Three Forks springsnail depends on adequate spring sites, reasonably protected from disturbance caused by soil erosion following wildfires or ungulate trampling and wallowing, exposure to fire retardant, water depletion and diversion, springhead inundation, and nonnative species (USFWS 2012). Once a springsnail population is extirpated from an area, there is a low probability of recolonization due to the geographic isolation between populations and their poor dispersal ability (Ponder and Colgan 2002).

Aquatic Component

The Three Forks springsnail occurs where water emerges from the ground as free-flowing springs and spring runs. Flowing water and proximity to the springhead is essential in providing the appropriate water chemistry, substrate, and flow characteristics necessary for the springsnails life-history processes. Their abundance decreases with increasing distance from spring vents, increasing water depth, and with decreasing temperatures (Martinez and Myers 2008; Martinez and Rogowski 2011; USFWS 2012). The Three Forks springsnail has been found to be associated with temperatures near 71.6° Fahrenheit (22° Celsius), shallow water up to 2.4 in (6 cm) deep, alkaline waters of pH 8, higher conductivity, and the presence of pond snails (*Physa gyrina*) (Martinez and Myers 2008; USFWS 2012). Density of the species was found to be greatest in water depths less than 2.2 in (5.6 cm), where density of pond snails (*Physa gyrina*) was less than 5.5/yard² (4.6/m²), and where distance from the springhead was less than 2.6 ft (0.8 m) (Martinez and Rogowski 2011).

The species was extirpated from Three Forks Springs following the 2004 Three Forks Fire and the airborne drift of a nearby application of fire retardant which was toxic to aquatic wildlife. The policy for delivery of wildland fire chemicals near waterways on USFS lands directs the USFS to avoid any ground application of wildland fire chemicals directly into waterways and to avoid aerial application of wildland fire chemicals within 300 ft (91 m) of waterways (NIFC 2012, p. 12-3). Although the closest delivery of fire retardant into a waterway was well over the 300-ft buffer (approximately 0.65 mi (1 km) upstream of Three Forks Springs), aquatic areas at Three Forks are still suspected to have been affected by the chemical drift (USFWS 2005, 2012).

The habitat of the Three Forks springsnail is currently threatened with reduction, destruction and modification due to the 2011 Wallow Fire which burned around the only two remaining populations (USFWS 2012). Intense fires destroy the protective ground cover of vegetation and forest litter, exposing soils to surface erosion during storms. This often leads to increased sedimentation downstream which can cause shifts in water temperature and chemistry, leaving the springsnails at risk. In order to reduce sediment loss during prescribed burning, maintaining a 66 ft (20 m) buffer strip around water in a steep watershed is recommended (Neary et al. 2008).

The degradation of spring run banks due to excessive ungulate trampling and crayfish burrowing, contributes to accelerated sedimentation and high turbidity. According to Hershler (1998), springs can be profoundly disturbed by ungulates “which modify the habitat both physically and chemically by trampling, removing aquatic and riparian vegetation, and depositing urine and feces.” Livestock have been excluded from springs where the Three Forks springsnail occurs with the utilization of fencing however, elk (*Cervus elaphus*) can still access all the springs since they are able to jump the fencing. Elk wallowing can prevent spring seepage from developing into free-flowing spring-runs, leads to sparse grass and soil loss, and causes muddy and stagnant water conditions, leaving the habitat unsuitable for the Three Forks springsnail (USFWS 2012).

The Three Forks springsnail was locally extirpated from concrete-boxed springheads following the invasion of nonnative crayfish. Springsnails lack the evolutionary mechanism to escape the unnatural predatory pressure of these relatively recent invaders which prey upon the snails and their eggs. Crayfish invasion is currently threatening the Three Forks springsnail across its entire range. The nonnative New Zealand mudsnail (*Potamopyrgus antipodarum*) is another invasive species of concern which out-competes native springsnails and slows their growth. Although not currently introduced into Three Forks springsnail habitat, this species is easily transported by birds and people and is currently spreading throughout the state (USFWS 2012).

Substrate Component

Three Forks springsnails are rarely found in soft sediments and are typically more abundant in gravel to cobble-sized substrates (Hershler 1998; Martinez and Myers 2008; Martinez and Rogowski 2011). The springsnails utilize firm substrates such as cobble, gravel, sand, woody debris, aquatic vegetation such as watercress, and leaf matter for cover and shelter. These substrates are essential for protection from predators and competitors and also increase productivity by providing suitable egg-laying sites, protection of young from predators, and provision of food resources. Degradation of spring banks due to excessive ungulate trampling and wallowing as well as the loss of vegetation following fires contributes to accelerated soil erosion, sedimentation and turbidity which leads to changes to microhabitat conditions such as shifts in substrate composition (USFWS 2012). When silt covers the rock and cobble bottoms of springsnail habitat, it may make it more difficult for snails to cling to the substrate and also adversely affect the periphyton upon which they feed (Dillon 1988). Poor habitat would be predominately silt and mud, stagnant water, overgrown vegetation (100% cover). A human-modified spring with concrete and pipe is not preferred, but depending on its design it may still support a population of springsnails.

Food Component

Three Forks springsnails feed primarily by scraping periphyton, a complex mixture of algae, detritus, bacteria, and other microbes, from submerged surfaces. Periphyton and the appropriate substrates that support its production are essential in providing forage to support physiological health of springsnails. (USFWS 2012)

MONITORING

Habitat

There are survey and monitoring protocols to document habitat conditions for springsnails. Water flow measuring devices are used to measure quantity of water emerging from the site which will show seasonal fluctuations. Water quality including depth, flow, temperature, pH, total dissolved salts for the site, as well as vegetation and substrate types and their percent cover should be recorded when monitoring habitat conditions. Quadrat ring sampling will allow for the evaluation of springsnail and habitat correlations as well as habitat quality trends.

Populations

Springsnails cannot be identified to the species in the field but must be identified in a laboratory by a qualified authority. A rule of thumb is that a springsnail species is specific to a particular spring and location, and therefore may be used as a means of preliminary identification. The Arizona Game and Fish Department has created survey and monitoring protocols for springsnails to document snail presence/absence and population size estimates. Instructions for surveying timed presence-absence at known sites include the following steps: Starting at the springhead, search a variety of substrate types (live vegetation, dead vegetation/debris, sand/silt, pebbles, and rocks); search various depths and distances from shore as well as various distances from the spring head; pick up gravel, debris, and leaf litter and inspect for snails; return snails where you found them. When the first springsnails are encountered, record their “start distance from the springhead” (in meters). When no more springsnails are seen, the search is stopped and “stop distance from springhead” is recorded along with total search time. Quadrat ring sampling will allow for the evaluation of springsnail population trends. According to Covington and DeBano (1994) population stability can be estimated by monitoring the surface area occupied or the boundary of occupation at the same time yearly.

KEY THREATS

Soil erosion during storm events following high-intensity wildfire.

- Intense fires destroy the protective ground cover of vegetation and forest litter, exposing soils to surface erosion during storms. This often leads to increased sedimentation downstream which can leave springsnails at risk by causing shifts in water temperature and chemistry.

Accidental application of aerial chemical fire retardant.

- Fire retardant is toxic to aquatic wildlife, and even if upholding the policy to avoid aerial application of chemicals within 300 ft (91 m) of waterways, aquatic areas can still be affected by the chemical drift.

Negative impacts from nonnative species

- These threats include predation and habitat destruction by crayfish as well as possible competition with New Zealand mudsnail.

Physical and chemical habitat destruction/alteration

- Accelerated sedimentation and high turbidity caused by excessive elk wallowing, as well as ungulate trampling, removing aquatic and riparian vegetation, and depositing urine and feces.
- Accelerated sedimentation and high turbidity caused by crayfish burrowing.

STANDARD HABITAT GUIDELINES AND MITIGATION MEASURES

- 1. Spring system – Adequately maintain clean (free from contamination) spring water emerging from the ground, shallow (up to 6 cm [2.35 in] deep) and flowing on the surface, and neutral to alkaline (pH between 7 and 9), such as free-flowing springs, spring runs, spring seeps, and shallow pond water, for individual and population growth and normal behavior.**

- 2. Periphyton – Maintain substrates that are conducive to the production of periphyton (attached algae), bacteria, and decaying organic material to provide forage to support physiological health.**
- 3. Substrates – Maintain substrates that include cobble, gravel, sand, woody debris, low to moderate cover of aquatic vegetation, and leaf matter to provide cover and shelter and for egg-laying, maturing, and feeding.**
- 4. Predation – Manage for the absence, or presence at low population levels, of nonnative predators such as crayfish and competitors such as New Zealand mudsnails.**
 - a. Control and eradicate invasive exotic competitors and predators.
 - b. Survey for New Zealand mudsnails to ensure early detection of possible future introductions.
- 5. Wildfire – Manage surrounding area to prevent hot canopy fires and the loss of vegetation and forest litter surrounding the spring complexes**
 - a. In order to reduce sediment loss during prescribed burning, maintaining a 66 ft (20m) buffer strip around water in a steep watershed is recommended.
- 6. Avoid aerial application of wildland fire chemicals within 300 ft of waterways and avoid any ground application of wildland fire chemicals into waterways.**
 - a. Evaluate on a case-by-case basis if the buffer should be increased to account for chemical drift.
- 7. Limit high-intensity ungulate grazing and wallowing within spring ecosystems. Refer to the ungulate section on page 5 of the AGFD fence guidelines (2011).**

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